

**PLASMIDS CONTAINING DNA-SEQUENCES THAT CAUSE CHANGES IN THE CARBOHYDRATE CONCENTRATION AND THE CARBOHYDRATE COMPOSITION IN PLANTS, AS WELL AS PLANT CELLS AND PLANTS CONTAINING THESE PLASMIDS**

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Plasmids are described having DNA sequences that after insertion into the genome of the plants cause changes in the carbohydrate concentration and the carbohydrate composition in regenerated plants. These changes can be obtained from a sequence of a branching enzyme that is located on these plasmids. This branching enzyme alters the amylose/amylopectin ratio in starch of the plants, especially in commercially used plants.

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<b>(21) International Application Number:</b> PCT/EP92/00302 <b>(22) International Filing Date:</b> 11 February 1992 (11.02.92) <b>(30) Priority data:</b> P 41 04 782.6 13 February 1991 (13.02.91) DE <b>(71) Applicant (for all designated States except US):</b> INSTITUT FÜR GENBIOLOGISCHE FORSCHUNG BERLIN GMBH [DE/DE]; Ihnestrasse 63, D-1000 Berlin 33 (DE). <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only) :</b> WILLMITZER, Lothar [DE/DE]; Am Kleinen Wannsee 34, D-1000 Berlin 39 (DE). SONNEWALD, Uwe [DE/DE]; Gierkezeile 34, D-1000 Berlin 10 (DE). KOSSMANN, Jens [DE/DE]; Koblenzer Strasse 1, D-1000 Berlin 31 (DE). MÜLLER-RÖBER, Bernd [DE/DE]; Lynarstrasse 5, D-1000 Berlin 65 (DE). VISSER, Richard, Gerardus, Francisus [NL/NL]; Van Broeckhuysenstraat 9, NL-6721 TC Bennekom (NL). JACOBSEN, Evert [NL/NL]; Rizema Bosweg 77, NL-6708 DK Wageningen (NL).		<b>(81) Designated States:</b> AT (European patent), AU, BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), HU, IT (European patent), JP, KR, LU (European patent), MC (European patent), NL (European patent), RU, SE (European patent), US.  <b>Published</b> <i>With international search report.</i>
<b>(54) Title:</b> PLASMIDS CONTAINING DNA-SEQUENCES THAT CAUSE CHANGES IN THE CARBOHYDRATE CONCENTRATION AND THE CARBOHYDRATE COMPOSITION IN PLANTS, AS WELL AS PLANT CELLS AND PLANTS CONTAINING THESE PLASMIDS  <b>(57) Abstract</b>  Plasmids are described having DNA sequences that after insertion into the genome of the plants cause changes in the carbohydrate concentration and the carbohydrate composition in regenerated plants. These changes can be obtained from a sequence of a branching enzyme that is located on these plasmids. This branching enzyme alters the amylose/amylopectin ratio in starch of the plants, especially in commercially used plants.		

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Plasmids containing DNA-Sequences that cause changes in the carbohydrate concentration and the carbohydrate composition in plants, as well as plant cells and plants containing these plasmids

5

The present invention relates to plasmids containing DNA-sequences which contain information that, after insertion into a plant genome, cause changes in the carbohydrate concentration and the carbohydrate composition in regenerated plants, as well as plant cells and plants containing sequences from these plasmids.

Because of the continual growth in world population, there is a continually growing demand for nutrient and raw materials. It is the task of biotechnological research to achieve a change of the content as well as yield of crops. To do this the metabolism of the plants has to be altered.

A particular interest is the possibility of using plant ingredients as renewable raw material sources e.g. for the chemical industry. This is especially of great importance for two reasons. Firstly, up to now, mineral oil and coal deposits have been the main source of raw materials for the petrochemical industry but these deposits are finite and it can be seen that alternative, renewable raw material sources must be developed.

Secondly, the present situation of agriculture in Europe and North America has lead to a surplus of crops grown for their nutritive properties. This causes obvious financial and political problems in agriculture. Alternative products for which there is a higher quantitative demand could be a solution to this problem.

Renewable raw materials can be divided into fats and oils, proteins and carbohydrates, such as mono-, di-, oligo- and

polysaccharides. The most important polysaccharides are starch and cellulose. In the EEC, the total starch production in 1987-1988 comprised maize (60%), wheat (19%) and potato (21%).

5 For an increasing use of plant starch as an industrial raw material the quality of the starch must meet the demands of the processing industry. Important considerations include the amylose to amylopectin ratio, the chain  
10 length, the branching grade of the amylopectin as well as the size of the starch granules.

The main biochemical synthetic pathways for the production of starch in higher plants are well known. Starch consists  
15 of amylose and amylopectin, in which the amylose consists of a linear  $\alpha$ -1,4-glucan and amylopectin consists of  $\alpha$ -1,4-glucans, which are connected to each other via  $\alpha$ -1,6-linkages and thus form a branched polyglucan. The so-called branching enzyme (Q-enzyme) is responsible for the  
20 introduction of the  $\alpha$ -1,6-linkage. One method for the production of starch which only has a linear  $\alpha$ -1,4-glucan structure is therefore by the inhibition of the enzymatic activity of the proteins and/or the inhibition of the biosynthesis of the branching enzyme. New biotechnology  
25 processes for the genetic alteration of dicotyledonous and monocotyledonous plants by transfer and stable installation of single isolated genes or groups of genes are known (Gasser and Fraley, Science 244, 1293-1299). The possibility of specific expression of foreign genes  
30 inserted in the plant by gene technology, primarily in potato tubers, is also known (EP 375092 and Rocha-Sosa et al., EMBO J. 8, 23-29 (1989)).

The present invention provides plasmids containing  
35 DNA-sequences which contain information that, after

insertion into a plant genome, cause changes in the carbohydrate concentration and the carbohydrate composition in regenerated plants.

- 5 The invention further provides plant cells containing sequences from these plasmids which can be regenerated to whole plants, as well as plants containing sequences from these plasmids.
- 10 The term "plant" means a commercially useful plant, preferably maize, barley, wheat, rice, peas, soya beans, sugar cane, sugar beet, tomato, potato or tobacco.

- Carbohydrates which can be altered by the DNA sequences are mono-, di-, oligo- or polysaccharides. Starch is an example of a polysaccharide which can be modified in plants and plant cells.
- 15

- With the plasmids of the invention, it is possible to modify the amylose to amylopectin ratio of the starch in plant cells and in plants. This is possible through the presence of a branching enzyme, located on the plasmid, which has the following sequence:
- 20

	10	20	30	40	50	60
1	TCAGGA	GC6GTCTT	GGGATATTTCTT	CCACCCCAAAATCA	AGAGTTAGAAA	AGATGAAAG
61	GATGAA	GCACAGTTCA	GCTATTTCCGCT	GTTTTGACCGAT	GACAATTCGACA	ATGGCACC
121	CCTAGAG	GAAGATGTCA	AACTGAAAATATT	GGCCTCCTAAATTT	GGATCCAAC	TTTGGGA
181	ACCTTAT	CTAGATCACTT	CAGACACAGAAT	GAAAGATATGT	GGATCAGAAA	ATGCTCAT
241	TGAAAA	ATATGAGGG	ACCCCTTGAGGA	ATTTGCTCAAG	GTATTTAAA	ATTTGGATTCAA
301	CAGGGA	AGATGGTTG	CATAGTCTATC	GTGAATGGGCT	CCTGCTGCTC	AGGAAGCAGAAGT
361	TATTGG	C6ATTTCAAT	G6TAGGAACG	6TTCTAACCAC	ATGATGGAGA	AGGACCAAGTTTGG
421	T6TTT	GGAGTATTAGA	ATTCCTGATGTT	GACAGTAAGCC	AGTCATTCCAC	ACAACCTCCAG
481	AGTTAA	GTTTTCTTT	CAAACATG6TA	ATGGAATG6G	6TAGATCGTAT	CCCTGCTTGGAT
541	AAAGTAT	GCCACTGCA	GACGCCACAA	AGTTTGCA	GCACCATATG	ATGGTGTCTACTGGGA
601	CCCACC	ACCTTCAGAA	AGGTACCACTT	CAAATACCCT	CGCCCTCCCA	AAACCCCGAGCCCC
661	ACGAAT	CTACGAAG	CACATGTCGG	CATGAGCAG	CTCTGAGCC	ACGTGTAAATTCGTATCG
721	TGAGTT	TGCAAT	GATGTTTTAC	CTCGGATTA	AGGCAAA	TAATACTATACTGTCCAATT

781 GATG6CCATAATGGAACATTCTTACTATGGATCATTTGGATATCATGTTACAAACTTTTT  
841 T6CTGTGA6CAATAGATATGGAAACCCGGAGGACCTAAAGTATCTGATAGATAAA6CACA  
901 TAGCTTGGGTTTACAG6TTCTGGTGGATGTAGTTCACAGTCATGCAAGCAATAATGTCAC  
961 T6ATG6CCTCAATG6CTTTGATATTGGCCAAG6TTCTCAAGAATCCTACTTTTCATGCTGG  
1021 AGAGCGAG6GTACCATAAGTTGTGGGATA6CA6GCTGTTCAACTATGCCAATTGGGAGGT  
1081 TCTTCGTTTCCTTCTTTCCAACCTTGAGGTGGTGGCTAGAAAGAGTATAACTTTGACG6ATT  
1141 TCSATTTGATGGAATAACTTCTATGCTGTATGTTTCATCATGGAATCAATATGGGATTAC  
1201 AGGAAACTATAATGAGTATTTGAGCGAGGCTACAGATGTTGATGCTGTGGTCTATTTAAT  
1261 GTTGGCCAATAATCTGATTCACAA6ATTTTCCAGACGCAACTGTTATTGCC6AAGATGT  
1321 TTCTGGTATGCCGGGCTTAGCCGGCTGTTTCTGA6GGAGGAATTGGTTTGGATTACGG  
1381 CCTGGCAATGGCAATCCCAGATAAGTGGATAGATTATTTAAAGAATAAGAATGATGAAGA  
1441 TTGGTCCATGAAGGAAGTAACATCGAGTTTGACAAATA6GAGATATACAGAGAAGTGTAT  
1501 AGCATATGCCGAGAGCCATGATCAGTCTATTGTG6GTGACAAGACCATTGCATTTCTCCT  
1561 AATGAACAAAAGAGATGTATTCTGGCATGTCTTGCTTGACAGATGCTTCTCCTGTTGTTGA  
1621 T6CAGGAATTGCGCTTGACAAGATGATCCATTTTTTTCACAATGGCCTTGGGAGGAGAGG  
1681 GGTACCTCAATTTTCATG6GTAA6GAGTTTG6CCATCCTGAGTGGATTGACTTCCCTAGTG  
1741 AGGGCAATAATTG6AGTTATGACAAATGTAGACGCCAGTGGAACTCGCAGATAGCGAAG  
1801 ACTTGAGATACAAAGTTTATGAATGCATTTGATAGAGCTATGAATTCGCTCGATGAAAAGT  
1861 TCTCATTCTCGCATCA6GAAAACAGATAGTAAGCA6CATGGATGATGATAATAAG6TTG  
1921 TTGTGTTTGAACGTGGTGACCTGGTATTTGTATTCAACTTCCACCCAAATAACACATACG  
1981 AAGGGTATAAAGTTGGATGTGACTTGGCA6GGAAGTACAGAGTTGCACTGGACAGTGTG  
2041 CTTGGGAATTTGGTGGCCATGGAAAGAGCTGGTCATGATGTTGACCATTTACATCACCAG  
2101 AAGGAATACCTGGAAGTTCCAGAAAACAAATTTCAATGGTCGTCCAAATTCCTTCAAAGTGC  
2161 TGTCTCCTGCGCAACATGTGTGGCTTATTACAGAGTTGATGAACGCATGTCATAAACTG  
2221 AAGATTACCAGACAGACATTTGTAGTGA6CTACTACCAACA6CCAATATCGAGGAAAAGTG  
2281 ACGAGAACTTAAAGATTCTCATCTACAAATATCAGTACATCATCTACAAAAAATGCTT  
2341 ATTACAGAGTTGATGAACGCATGTGAGAACTGAAAGATTACCAGACAGACATTTGTAGTG  
2401 AGCTACTACTACCAACA6CCAATATCGAGGAGAAGTGAAGAACTTGATGATTCATTAT  
2461 CTACAAATATCA6TAACATTGGTCA6ACTGTTGTAGTTTCTGTTGAGGAGAGAGACAAGG  
2521 AACTTAAAGATTCAACATCTGTAA6CATCATTAGTGATGCTGTTCCAGCTGAATGGGCTG  
2581 ATTCGGATGCAAACGTCTGGG6TGAGGACTAGTCA6ATGATTGATCGATCCTTCTACGTT  
2641 GGTGATCTCGGTCCGTGCATGATGTCTTCAGGGTGGTAGCATTGACTGATTGCATCATAG  
2701 TTTTTTTTTTTTTTTTAA6TATTTCTCTATG6CATATTATTAGCATCCAATAAATTTAC  
2761 TGGTTGTTGTACATAGAAAAAGTGCATTTG6CATGTATGTGTTTCTCTGAAATTTTCCCCA  
2821 GTTTTGGTCTTTG6CCTTTGGAGCCAAAGTCTCTATATGTAATAAGAAAACTAAGAACAAT  
2881 CACATATATAAAATGTTAGTGA6ATTACCA .



The property of the branching enzyme to modify the amylose/amylopectin ratio in starch is not limited to a coding sequence exactly as it is shown here but can also be represented by slightly different nucleotid sequences.

- 5 The property of the branching enzyme is also not changed when the plasmids containing the branching enzyme, are modified in the plant cell or the plant.

- 10 To be active, the DNA sequence of the branching enzyme is fused to the regulatory sequences of other genes which guarantee a transcription of the DNA (coding) sequence of the branching enzyme. The DNA sequence can also be fused in an inverted direction to the regulatory sequences of other genes, whereby the 3'-end of the coding sequence is fused to the 3'-end of the promoter and the 5'-end of the coding sequence is fused to the 5'-end of the termination signal. In this way an anti-sense RNA of the branching enzyme is produced in the plant. The regulatory sequences are hereby promoters and termination signals of plant or
- 15 20 viral genes, such as for example the promoter of the 35S RNA of the cauliflower mosaic virus or the promoter of the class I patatin-gene B 33 and the termination signal of the 3'-end of the octopine synthase gene of the T-DNA of the Ti-plasmid pTiACH5.

- 25 Plant cells containing sequences from these plasmids can be regenerated in known manner to complete transgenic plants. It is possible to insert simultaneously, more than one copy of these sequences into a plant cell or plant.

The following plasmids were deposited at the Deutsche Sammlung von Mikroorganismen (DSM) in Braunschweig, Germany on the 20th August 1990 (deposit number):

- |   |         |               |            |
|---|---------|---------------|------------|
| 5 | Plasmid | P35 S-BE      | (DSM 6143) |
|   | Plasmid | P35 S-anti-BE | (DSM 6144) |
|   | Plasmid | P33-BE        | (DSM 6145) |
|   | Plasmid | P33-anti-BE   | (DSM 6146) |

10 Description of the Figures

Figure 1 shows the restriction map of the 13.6 kb plasmid P35 S-BE. The plasmid contains the following fragments.

- |    |   |   |  |
|----|---|---|--|
| 15 | A | = | Fragment A (529 bp) contains the 35S promoter of the cauliflower mosaic virus (CaMV). The fragment contains the nucleotides 6909-7437 of the cauliflower mosaic virus. |
| 20 | B | = | Fragment B (2909 bp) contains the DNA fragment which codes for the branching enzyme.   |
|    | C | = | Fragment C (192 bp) contains the polyadenylation signal of the gene 3 of the T-DNA of the  |
| 25 |   |   | Ti-plasmid pTiACH5 from the nucleotide 11749 to 11939.   |

Also shown are the cleavage sites described in Example 1.

- 30 Figure 2 shows the restriction map of the 13.6 kb plasmid P35 S-anti-BE. The plasmid contains the following fragments:

- |    |   |   |   |
|----|---|---|---|
| 35 | A | = | Fragment A (529 bp) contains the 35S promoter of the cauliflower mosaic virus (CaMV). The |
|----|---|---|---|

fragment contains the nucleotides 6909 to 7437 of the CaMV.

5        B        =        Fragment B (2909 bp) contains the DNA fragment which codes for the branching enzyme.

         C        =        Fragment C (192 bp) contains the polyadenylation signal of gene 3 of the T-DNA of the Ti-plasmid pTiACH5. The fragment contains the nucleotides  
10                            11749-11939.

Also shown are the cleavage sites described in Example 2.

15        Figure 3 shows the restriction map of the 14.6 kb plasmid P33-BE. The plasmid contains the following fragments.

20        A        =        Fragment A (1526 bp) contains the DraI-DraI-fragment of the promoter region of the patatin-gene B33. The fragment contains the nucleotide positions -1512 to +14.

         B        =        Fragment B (2909 bp) contains the DNA fragment which codes for the branching enzyme.

25        C        =        Fragment C (192 bp) contains the polyadenylation signal of the gene 3 of the T-DNA of the Ti-plasmid pTiACH5. The fragment contains the nucleotide positions 11749-11939.

30        Also shown are the cleavage sites described in Example 3.

Figure 4 shows the restriction map of the 14.6 plasmid P33-anti-BE. Plasmid contains the following fragments:

35        A        =        Fragment A (1526 bp) contains the DraI-DraI

fragment of the promoter region of the patatin gene B 33. The fragment contains the nucleotide position -1512 to +14.

- 5    B    =    Fragment B (2909 bp) contains the cDNA-fragment which codes for the branching enzyme.
- C    =    Fragment C (192 bp) contains the polyadenylation signal of the gene 3 of the T-DNA of the
- 10       Ti-plasmid pTiACH5. The fragment contains the nucleotides 11749-11939.

Also shown are the cleavage sites described in Example 4.

- 15    In order to understand the examples forming the basis of this invention all the processes necessary for these tests and which are known per se will first of all be listed:

1.    Cloning process

- 20       The vectors pUC18/19 and pUC118, and the M13mp10 series (Yanisch-Perron et al., Gene (1985), 33, 103-119) were used for cloning.

- 25       For plant transformation, the gene constructions were cloned into the binary vector BIN19 (Bevan, Nucl. Acids Res. (1984), 12, 8711-8720).

2.    Bacterial strains

- 30       The E. coli strain BMH71-18 (Messing et al., Proc. Natl. Acad. Sci. USA (1977), 24, 6342-6346) or TB1 was used for the pUC and M13 mP vectors.

- 35       For the vector BIN19 exclusively the E. coli strain TB1 was used. TB1 is a recombinant-negative, tetracycline-resistant derivative of strain JM101

(Yanisch-Perron et al., Gene (1985), 33, 103-119).  
The genotype of the TB1 strain is (Bart Barrel,  
personal communication): F'(traD36, proAB, lacI,  
lacZAM15), Δ(lac, pro), SupE, thiS, recA,  
Srl::Tn10(TcR).

The transformation of the plasmids into the potato  
plants was carried out by means of the Agrobacterium  
tumefaciens strain LBA4404 (Bevan, M., Nucl. Acids  
Res. 12, 8711-8721, (1984); BIN19 derivative).

3. Transformation of Agrobacterium tumefaciens

In the case of BIN19 derivatives, the insertion of  
the DNA into the agrobacteria was effected by direct  
transformation in accordance with the method  
developed by Holsters et al., (Mol. Gen. Genet.  
(1978), 163, 181-187). The plasmid DNA of transformed  
agrobacteria was isolated in accordance with the  
method developed by Birnboim and Doly (Nucl. Acids  
Res. (1979), 7, 1513-1523) and was separated by gel  
electrophoresis after suitable restriction cleavage.

4. Plant transformation

10 small leaves, wounded with a scalpel, of a sterile  
potato culture were placed in 10 ml of MS medium with  
2 % sucrose containing from 30 to 50 μl of an  
Agrobacterium tumefaciens overnight culture grown  
under selection. After from 3 to 5 minutes gentle  
shaking, the Petri dishes were incubated in the dark  
at 25°C. After 2 days, the leaves were laid out on MS  
medium with 1.6 % glucose, 2 mg/l of zeatin ribose,  
0.02 mg/l of naphthylacetic acid, 0.02 mg/l of  
gibberellic acid, 500 mg/l of claforan, 50 mg/l of  
kanamycin and 0.8 % Bacto agar. After incubation for  
one week at 25°C and 3000 lux, the claforan

concentration in the medium was reduced by half. The regeneration and cultivation of the plants were carried out according to known processes (Rocha-Sosa et al EMBO Journal 8, 23-29 (1989)).

5

5. Analysis of genomic DNA from transgenic potato plants  
The isolation of genomic plant DNA was effected in accordance with Rogers and Bendich (Plant Mol. Biol. (1985), 5, 69-76.

10

For the DNA analysis, after suitable restriction cleavage, 10 to 20  $\mu$ g of DNA were analysed by means of Southern blots for the integration of the DNA sequences to be investigated.

15

6. Analysis of the total RNA from transgenic potato plants  
The isolation of plant total RNA was carried out in accordance with Logemann et al. (Analytical Biochem. (1987), 163, 16-20).

20

For the analysis, 50  $\mu$ g portions of total RNA were investigated by means of Northern blots for the presence of the transcripts sought.

25

7. Protein extraction  
For the extraction of total protein from plant tissue, pieces of tissue were homogenised in protein extraction buffer (25 mM sodium phosphate pH 7.0, 2 mM sodium hydrogen sulphite), with the addition of 0.1 % (w/v) of insoluble polyvinylpyrrolidone (PVP).

30

After filtration through cellulose, cell detritus was centrifuged off for 20 minutes at 10,000 revolutions per minute and the protein concentration of the

35

supernatant was determined in accordance with the method developed by Bradford (Anal. Biochem. (1976)/ 72, 248-254).

5    8.    Detection of foreign proteins by means of immunological processes (Western blot)

10    The protein extracts were separated according to molecular weight by means of gel electrophoresis in SDS-PAGE (sodium dodecylsulphate polyacrylamide) gels. After SDS-PAGE the protein gels were  
15    equilibrated for from 15 to 30 minutes in transfer buffer for graphite electrodes (48 g/l of tris, 39 g/l of glycine, 0.0375 % SDS, 20 % methanol) and then transferred in a cooling chamber to a nitrocellulose filter and separated at 1.3 mA/cm<sup>2</sup> for from 1 to 2  
20    hours. The filter was saturated for 30 minutes with 3 % gelatin in TBS buffer (20 mM tris/HCl pH 7.5, 500 mM NaCl), and the filter was then incubated for 2 hours with the appropriate antiserum in a suitable  
25    dilution (1:1000 - 10000 in TBS buffer) at room temperature. The filter was then washed for 15 minutes each with TBS, TTBS (TBS buffer with 0.1% polyoxyethylene-(20)-sorbitan monolaurate) and TBS buffer. After being washed, the filter was incubated  
30    for 1 hour at room temperature with alkaline phosphatase-conjugated goat-anti-rabbit (GAR) antibodies (1:7500 in TBS). The filter was then washed as described above and equilibrated in AP buffer (100 mM tris/HCl pH 9.5, 100 mM NaCl, 5 mM  
35    MgCl<sub>2</sub>). The alkaline phosphatase reaction was started by means of the substrate addition of 70 µl of 4-nitrotetrazolium (NBT) solution (50 mg/ml of NBT in 70 % dimethyl-formamide) and 35 µl of 5-bromo-4-chloro-3-indolyl phosphate (BCIP) (50 mg/ml BCIP in dimethylformamide) in 50 ml of AP buffer. As a rule

the first signals were observed after 5 minutes.

9. Determination of the amylose/amylopectin ratio in starch of transgenic potato plants.

5 Leaf pieces, having a diameter of 10 mm were floated in 6% sucrose solution under continuous light for 14 hours. This light incubation induced a strong increased starch formation in the leaf pieces. After incubation, the amylose and amylopectin concentration was determined according to Hovenkamp-Hermelink et al  
10 (Potato Research 31, 241-246 (1988)).

The following examples illustrate the preparation of the plasmids according to the invention, the insertion of  
15 sequences from those plasmids into the plant cell as well as regeneration of transgenic plants and the analysis of those transgenic plants.

Example 1

20 Preparation of the plasmid P35s-Be and insertion of the plasmid into the plant genome of the potato.

From a cDNA library in the expression vector  $\lambda$ gt11, different clones were identified that cross-react with an  
25 antibody that is directed against the branching enzyme of potatoes. These clones were used to identify complete clones from a cDNA library in the HindIII-position the vector pUC 19 that originate from isolated mRNA of growing potato tubers. One clone isolated in this manner had an  
30 insert size of 2909 bp of the sequence:



10 20 30 40 50 60

1 TCAGGAGCGGCTTTGGGATATTTCTTCCACCCCAAATCAAGAGTTAGAAAAAGATGAAAG  
61 GATGAAGCACAGTTCACTATTTCCGCTGTTTTGACC6ATGACAATTGACAATGGCACC  
121 CCTAGAGGAAAGATGTCAACACTGAAAATATTGGCCTCCTAAATTTGGATCCAACTTTGGA  
181 ACCTTATCTAGATCACTTCAGACACAGAATGAAGAGATATGTGGATCAGAAAATGCTCAT  
241 TGAAAAATATGAAGGACCCCTTGAGGAATTTGCTCAAAGTTATTTAAAAATTTGGATTCAA  
301 CAAGGAGAGATGGTTGCATAGTCTATCGTGAATGGGCTCCTGCTGCTCAGGAAAGCAAGT  
361 TATTGGCGATTTCAATGGTAGGAACGGTTCTAACCACATGATGGAGAGGAGGACAGTTTGG  
421 TGTGGAGTATTAGAATTCCTGATGTTGACAGTAAGCCAGTCATTCCACACAACCTCCAG  
481 AGTTAAGTTTCGTTTCAAACATGGTAATGGAGTGTGGGATAGATCGTATCCCTGCTTGGAT  
541 AAAATATGCCACTGCAGACGCCACAAAGTTTGCAGCACCATATGATGGTGTCTACTGGGA  
601 CCCACCACCTTCAGAAAAGTACCACTTCAAATACCCTCGCCCTCCCAAACCCGAGCCCC  
661 ACGAATCTACGAAGCACATGTGGCATGAGCAGCTCTGAGCCACGTGTAAATTCGTATCG  
721 TGAATTTGCAGATGATGTTTTACCTCGGATTAAGGCAAATAACTATAATACTGTCCAATT  
781 GATGGCCATAATGGAACATTCTTACTATGGATCATTTGGATATCATGTTACAAACTTTTT  
841 TGCTGTGAGCAATAGATATGGAACCCGGAGGACCTAAAGTATCTGATAGATAAAGCACA  
901 TAGCTTGGGTTTACAGGTTCTGGTGGATGTAGTTCAAGTCATGCAAGCAATAATGTCA  
961 TGATGGCCTCAATGGCTTTGATATTGGCAAAGTTCTCAAGAATCCTACTTTTCATGCTGG  
1021 AGAGCGAGGGTACCATAAGTTGTGGGATAGCAGGCTGTTCAACTATGCCAATTGGGAGGT  
1081 TCTTCGTTTCCTTCTTTCCAACCTTGAAGTGGTGGCTAGAGAGTATAACTTTGACGGATT  
1141 TCGATTTGATGGAATAACTTCTATGCTGTATGTTTCATCATGGAATCAATATGGGATTAC  
1201 AGGAACTATAATGAGTATTTGAGCGAGGCTACAGATGTTGATGCTGTGGTCTATTTAAT  
1261 GTTGGCCAATAATCTGATTCACAAGATTTTCCAGACGCAACTGTTATTGCCGAAGATGT  
1321 TTCTGGTATGCCGGGCTTAGCCGGCTGTTTCTGAGGGAGGAATTGGTTTTGATTACCG  
1381 CCTGGCAATGGCAATCCAGATAAGTGGATAGATTATTTAAAGAATAAGAATGATGAAGA  
1441 TTGGTCCATGAAGGAAGTAACATCGAGTTTGAAGATAAGAGATATACAGAGAAGTGTAT  
1501 AGCATATGCGGAGAGCCATGATCACTATTGTCGGTGAAGAGACCATTGCAATTTCTCCT  
1561 AATGAACAAAGAGATGTATTCTGGCATGTCTTGGTGGACAGATGCTTCTCTGTTGTTGA  
1621 TGCAAGGAATTGCGCTTGACAAGATGATCCATTTTTTTCACAATGGCCTTGGGAAGAGAGG  
1681 GGTACCTCAATTTTCATGGGTAACGAGTTTGGCCATCCTGAGTGGATTGACTTCCCTAGTG  
1741 AGGGCAATAATTGGAATTATGACAAATGTAGAGCGCAGTGGAACTCGCAGATAGCGAAC  
1801 ACTTGAGATACAAATTTATGAATGCATTTGATAGAGCTATGAATTCGCTCGATGAAAAAT  
1861 TCTCATTCTCGCATGAGGAAACAGATAGTAAGCAAGCATGGATGATGATAATAAGGTTG  
1921 TTGTGTTTGAACGTGGTGGCTGTTTGTATTCAACTTCCACCCAAATAACACATACG

10 20 30 40 50 60  
1981 AAGGGTATAAAGTTGGATGTGACTTGCCAGGGAAGTACAGAGTTGCACTGGACAGTGATG  
2041 CTTGGGAATTTGGTGGCCATGGAAAGAGCTGGTCATGATGTTGACCATTTACATCACCAG  
2101 AAGGAATACCTGGAGTTCCAGAAACAAATTTCAATGGTCGTCCAAATTCCTTCAAAGTGC  
2161 TGTCTCCTGCGCGAACATGTGTGGCTTATTACAGAATTGATGAACGCATGTCATAAACTG  
2221 AAGATTACCAGACAGACATTTGTAGTGAAGCTACTACCAACAGCCAATATCGAGGAAAAGTG  
2281 ACGAGAAACTTAAAGATTCATCATCTACAAATATCAGTACATCATCTACAAAAAATGCTT  
2341 ATTACAGAATTGATGAACGCATGTCAGAAGCTGAAAGATTACCAGACAGACATTTGTAGTG  
2401 AGCTACTACTACCAACAGCCAATATCGAGGAGAAGTACGAGAAACTTGATGATTCATTAT  
2461 CTACAAATATCAGTAACATTGGTCAGACTGTTGTAGTTTCTGTTGAGGAGAGAGACAAAG  
2521 AACTTAAAGATTACCATCTGTAAGCATCATTAGTGATGCTGTTCCAGCTGAATGGGCTG  
2581 ATTCGGATGCAAAACGTCTGGGGTGAAGACTAGTCAGATGATTGATCGATCCTTCTACGTT  
2641 GGTGATCTCGGTCCGTGCATGATGTCCTTCAAGGTTGGTAGCATTGACTGATTGCATCATAG  
2701 TTTTTTTTTTTTTTTTTTAAAGTATTTCTCTATGCATATTATTAGCATCCAATAAATTTAC  
2761 TGTTTGTGTACATAGAAAAAGTGCAATTTGCATGTATGTGTTTCTCTGAAATTTTCCCA  
2821 GTTTTGGTGTCTTGCCTTTGGAGCCAAGTCTCTATATGTAATAAGAAAACTAAGAACAAT  
2881 CACATATATAAAATGTTAGTAGATTACCA .

The 2909 bp long c-DNA contained in this clone was used for the next examples and is called cBE.

5 For the preparation of a plasmid p35s-BE, this cDNA was provided with the promoter of the 35s-RNA of the cauliflower mosaic virus as well as the polyadenylation signal of the octopine synthase gene of the Ti-plasmid pTiACH5. For this the orientation of the C-DNA coding for  
10 the branching enzyme was chosen in such a way that the coding strain will be readable (sense-orientation). The plasmid p35s-BE has a size of 13.6 kb and comprises the three fragments A, B and C which were cloned into the cleavage sites of the polylinker of BIN19.

15

Fragment A (529 bp) contains the 35s promoter of the cauliflower mosaic virus (CaMV). The fragment contains the nucleotides 6909 to 7437 of the CaMV (Franck et al., Cell  
21, 285-294). It was isolated as EcoRI-KpnI-fragment from  
20 the plasmid pDH51 (Pietrzak et al, Nucleic Acids Research 14, 5857-5868) and was cloned between the EcoRI-KpnI-cleavage position of the polylinker of the plasmid BIN 19.

Fragment B contains a 2909 bp cDNA fragment cBe which  
25 codes for the branching enzyme. It was cut out as HindIII-SmaI-fragment of the vector pUC 19 and was cloned into the SmaI-position of the polylinker of BIN 19 after filling-in of the Hind-III-position with DNA polymerase. For this the orientation of the cDNA was chosen in such a way that the  
30 coding strand is readable and a sense-RNA is formed. The cleavage sites BamHI/XbaI and PstI/SphI originate from the polylinker of pUC 19. The cleavage sites BamHI/XbaI/SalI/PstI originate from the polylinker of BIN 19. The two  
EcoRI cleavage sites located on the fragment B are  
35 internal cleavage sites of the fragment.

- Fragment C (192 bp) contains the polyadenylation signal of the gene 3 of the T-DNA of the Ti-plasmid pTiACH5 (Gielen et al EMBO J. 3, 835,846), nucleotides 11749-11939, which are isolated as PvuII-HindIII fragment from the plasmid pAGV 40 (Herrera-Estrella et al (1983) Nature 303, 209-213) and were then cloned onto the PvuII cleavage site between the SphI-Hind-III cleavage site of the polylinker of BIN 19, after addition of SphI linkers (see Fig 1).
- 10 The plasmid p35s-BE was transferred into potatoes with the help of the agrobacterial system. After this whole plants were regenerated. Protein extracts isolated from tubers of these plants were tested for the existence of the branching enzyme using the western blot analysis. Further, tubers of these plants were tested for the content of amylose and amylopectin.

#### Example 2

- Preparation of the plasmid p35s-anti-BE and introduction of the plasmid the plant genome of potato.

In a similar manner to that described in Example 1, the plasmid p35s-anti-BE was prepared, but the orientation of the designated cDNA of the branching enzyme was inverted relative to the 35 S promotor. The plasmid p35s-anti-BE has a size of 13.6 kb and comprises the three fragments A, B and C which were cloned in the cleavage sites of the polylinker of BIN19.

- 30 Fragment A (529 bp) contains the 35s promoter of the cauliflower mosaic virus (CaMV). The fragment contains the nucleotides 6909 to 7437 of the CaMV (Franck et al. Cell 21, 285-294), and was isolated as EcoRI-KpnI-fragment from the plasmid pDH51 (Pietrzak et al Nucleic Acids Research 14, 5857-5868) and cloned between the EcoRI-KpnI-cleavage
- 35

site of the polylinker of the plasmid BIN 19.

Fragment B contains the 2909 bp cDNA fragment cBE which codes for the branching enzyme. It was cut from the HindIII-SmaI-fragment of the vector pUC 19 and cloned in the SmaI-position of the polylinker BIN 19 after filling in of the HindIII-position with DNA polymerase. The orientation was chosen in such a way that the non-coding strand is readable and an anti-sense-RNA is formed. The cleavage sites SphI, PstI and XbaI, BamHI, SmaI originate from the polylinker pUC 19. The cutting positions BamHI/XbaI/SalI/PstI originate from the polylinker of BIN 19. The two EcoRI cleavage sites contained on the fragment B are internal cleavage sites of this fragment.

Fragment C (192 bp) contains the polyadenylation signal of gene 3 of the T-DNA of the TI-plasmid pTiACH5 (Gielen et al EMBO J 3, 835-846), nucleotides 11749-11939, which were isolated as PvuII-HindIII-fragment from the plasmid pAGV 40 (Herrera-Estrella et al (1983), and which were cloned between the SphI-HindIII-cleavage position of the polylinker of BIN 19 after addition of Sph-I-linkers to the Pvu-II-cleavage position (see Fig 2).

The plasmid p35s-anti-BE was transferred into potatoes using the agrobacterial system. After this whole plants were regenerated.

Protein extracts, which had been isolated from tubers of these plants, were tested for the existence of the branching enzyme using the western blot analysis. Tubers of these plants were also tested for the content of amylose and amylopectin.

Example 3Preparation of the plasmid p33-BE and introduction of the plasmid into the plant genome of the potato.

5 In a similar manner to that described in Example 1, the plasmid p33-BE was prepared, but replacing the 35s promoter with the promoter of the class I patatin-gene B33 (Rocha-Sosa et al EMBO J 8 23-29). The plasmid p33-Be has a size of 14.6 kb and consists of the three fragments A, B  
10 and C that were cloned into the cleavage position of the polylinker of BIN 19.

Fragment A contains the DraI-DraI-fragment (position -1512 to position +14) of the promoter region of the patatin-gene B33 (Rocha-Sosa et al EMBO J 8. 23-29), which was  
15 first of all cloned into the SacI-position of the polylinker of pUC 18. For this the overhanging 3'- end of the Sac-I-cleavage site had been rendered blunt by T4-DNA polymerase. After this the EcoRI-BamHI-fragment was  
20 inserted between the EcoRI-BamHI-position of the polylinker of BIN 19.

Fragment B contains the 2909 bp cDNA fragment cBE which codes for the branching enzyme. It was cut out as HindIII-SmaI-fragment from the vector pUC 19 and was cloned into  
25 the SmaI-position of the polylinker of BIN 19 after the HindIII-position was filled in with DNA polymerase. For this the orientation of the cDNA was chosen in such a way that the coding strand was readable and a sense-RNA was  
30 formed. The cleavage sites BamHI/XbaI and PstI/SphI originate from the polylinker of pUC 19. The cutting positions BamHI/XbaI/SalI/PstI originate from the polylinker of BIN 19. The two EcoRI-cleavage sites contained on the fragment B are internal cleavage sites of  
35 this fragment.

19

Fragment C (192 bp) contains the polyadenylation signal of gene 3 of the T-DNA of the Ti-plasmid PtiACH5 (Gielen et al EMBO J 3, 835-846, Nucleotide 11749-11939), which was isolated as Pvu-II-HindIII-fragment from the plasmid pAGV 40 (Herrera-Estrella et al (1983) Nature 303, 209-213) and which was cloned between the SphI-HindIII-cleavage site of the polylinker of BIN 19 after addition of SphI-linkers to the PvuII-cleavage site.

10 The plasmid p33-BE was transferred into Agrobacterium tumefaciens and used for the transformation of potato plants.

#### Example 4

15 Preparation of the plasmid p33-anti-BE and introduction of plasmid into the plant genome of potato.

In a similar manner to that described in Example 2, plasmid p33-anti-BE was prepared but replacing the 35S-promoter with the promoter of the class I patatin-gene B33 (Rocha-Sosa et al EMBO J 8, 23-29). The plasmid p33-anti-Be has a size of 14.6 kb and consists of three fragments A, B and C which were cloned into the cleavage sites of the polylinker of BIN 19.

25 Fragment A contains the DraI-DraI-fragment (position -1512 to position +14) of the promoter region of the patatin-gene B33 (Rocha-Sosa et al EMBO J 8, 23-29) which was firstly cloned into the SacI-position of the polylinker of pUC 18. The overhanging 3'-ends of the SacI-cleavage site were rendered blunt by T4-DNA polymerase. After this the fragment was inserted as EcoRI-BamHI-fragment between the EcoRI-BamHI-position of the polylinker of BIN 19.

35 Fragment B contains the 2909 bp cDNA fragment cBE which

codes for the branching enzyme. It was cut out as HindIII-SmaI-fragment from the vector pUC 18 and after filling in the HindIII-position with the DNA polymerase, it was cloned into the SmaI-position of the polylinker of BIN 19.

5 For this the orientation of the cDNA was chosen in such a manner that the non-coding strand was readable and anti-sense-RNA could be formed. The cutting positions SphI, PstI and XbaI, BamHI, SmaI originate from the polylinker of pUC 19. The cutting positions BamHI/ XbaI/SalI/PstI

10 originate from the polylinker of BIN 19. The two EcoRI cleavage sites which are located on the fragment B are internal cleavage sites of the fragment.

Fragment C (192 bp) contains the polyadenylation signal of the gene 3 of the T-DNA of the Ti-plasmid pTiACH5 (Gielen et al EMBO J 3, 835-846), Nucleotides 11749-11939), which had been isolated as PvuII-HindIII-fragment from the plasmid pAGV 40 (Herrera-Estrella et al (1983), Nature 303, 209-213) and which was cloned between the SphI-

20 HindIII-cleavage site of the polylinker of BIN 19 after addition of SphI-linkers to the PvuII cleavage sites.

The plasmid p33-anti-BE was introduced in Agrobacterium tumefaciens and was used for the transformation of potato

25 plants.

#### Example 5

The nucleotides 166-2909 of the 2909 bp cDNA sequence described in Example 1, that codes for the branching enzyme in the HindII-cleavage site of the cloning vector pUC 19 were inserted into the corresponding cleavage sites of the polylinker of the cloning vector pUC 18. This makes possible a fusion of the N-end of the  $\alpha$ -peptide of the  $\beta$ -galactosidase located on the vector with a part of the

35 branching enzyme. The functionality of the resulting



- fusion protein was tested in a mutant of Escherichia coli (KV 832) which is deficient in the branching enzyme (Kiel et al Gene 78, 9 - 17). Cells transformed with this construction were plated out on YT-agar plates containing
- 5 0.5% glucose. The resulting colonies were stained with Lugolscher solution. The transformed plant cells showed a yellow-red colour in contrast to the blue coloured un-transformed plant cells which indicates the branching activity of the fusion protein (Kiel et al Gene 78, 9-17).
- 10 An over-production of this protein in Escherichia coli enables the use as technical enzyme.

Claims

1. A plasmid that contains a DNA sequence that contains information that causes changes in the carbohydrate concentration and the carbohydrate composition in regenerated plants, after insertion into the plant genome.
2. A plasmid according to Claim 1 characterised in that the DNA sequence is the coding sequence of a branching enzyme.
3. A plasmid according to Claim 2 characterised in that the branching enzyme is an enzyme having the following sequence:
- ```

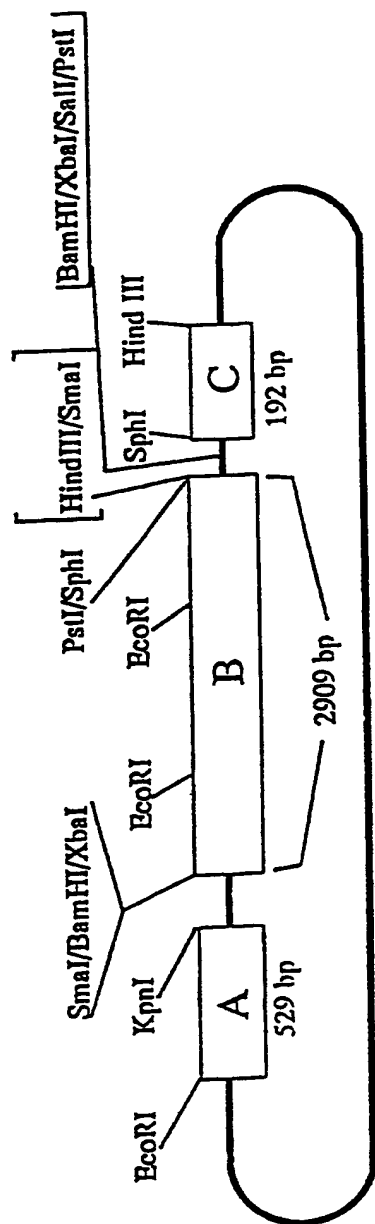
      10      20      30      40      50      60
1  TCAGGAGCGGTCTTGGGATATTTCTTCCACCCCAAAATCAAGAGTTAGAAAAGATGAAAG
61  GATGAAAGCACAGTTCA6CTATTTCCGCTGTTTTGACCGATGACAATTCGACAATGGCACC
121 CCTAGAGGAAGATGTCAACACTGAAAAATATTGGCCTCCTAAATTTGGATCCAACTTTGGA
181 ACCTTATCTAGATCACTTCAGACACAGAATGAAGAGATATGTGGATCAGAAAAATGCTCAT
241 TGA AAAATATGAGGGACCCCTTGAAGGAATTTGCTCAAGGTTATTTAAAAATTTGGATTCAA
301 CAGGGAAAGATGGTTGCATAGTCTATCGTGAATGGGCTCCTGCTGCTCAGGAAGCAGAAGT
361 TATTGGCGATTTCAATGGTAGGAACGGTTCTAACCACATGATGGAGAAGGACCAAGTTTGG
541 AAAGTATGCCACTGCAGACGCCACAAAGTTTGCAGCACCATATGATGGTGTCTACTGGGA
601 CCCACCACCTTCAGAAAAGGTACCACTTCAAATACCCTCGCCCTCCCAAACCCGAGCCCC
661 ACGAATCTACGAAGCACATGTCGGCATGAGCAGCTCTGAGCCACGTGTAAATTGCTATCG
721 TGAGTTTGCAGATGATGTTTTACCTCGGATTAAGGCAAATAACTATAATACTGTCCAATT
781 GATGGCCATAATGGAACATTCTTACTATGGATCATTTGGATATCATGTTACAAACTTTTT
841 TGCTGTGAGCAATAGATATGAAAACCCGGAAGACCTAAAGTATCTGATAGATAAAGCACA
901 TAGCTTGGGTTTACAAGTTCTGGTGGATGTAGTTCACAATCATGCAAGCAATAATGTCAC
961 TGATGGCCTCAATGGCTTTGATATTGGCCAAGGTTCTCAAGAATCCTACTTTCATGCTGG
1021 AGAGCGAGGGTACCATAAGTTGTGGGATAGCAAGCTGTTCAACTATGCCAATTGGGAGGT
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1081 TCTTCGTTTCCTTCTTTCCAACCTTGAAGTGGTGGCTAGAAGAGTATAACTTTGACGGATT  
1141 TC6ATTTGATGGAATAACTTCTATGCTGTATGTTTCATCATGGAATCAATATGGGATTTAC  
1201 AGGAACTATAATGAATTTTCAAGCAAGGCTACAGATGTTGATGCTGTGGTCTATTTAAT  
1261 GTTGGCCAATAATCTGATTCACAAATTTTCCAGACGCAACTGTTATTGCCGAAGATGT  
1321 TTCTGGTATGCCGGGCTTAGCCGGCCTGTTTCTGAAGGAGGAATTGGTTTTGATTACCG  
1381 CCTGGCAATGGCAATCCCAGATAAGTGGATAAGATTATTTAAAGAATAAGAATGATGAAGA  
1441 TTGGTCCATGAAGGAAGTAACATCGAGTTTGACAAATAGGAGATATACAGAGAAAGTGAT  
1501 AGCATATGCGGAGAGCCATGATCAGTCTATTGTCGGTGAAGAAGACCATTGCAATTTCTCCT  
1561 AATGAACAAAAGAGATGATTCTGGCATGTCTTGCTTGACAGATGCTTCTCCTGTTGTTGA  
1621 TGACGGAATTGCGCTTGACAAAGATGATCCATTTTTTTCACAAATGGCCTTGGGAGGAGAGG  
1681 GGTACCTCAATTTTCATGGGTAACGAGTTTGGCCATCCTGAGTGGATTGACTTCCCTAAGT  
1741 AGGGCAATAATTGGAAGTTATGACAAATGTAGACGCCAGTGGAACTCGCAGATAGCGAAC  
1801 ACTTGAGATACAAAGTTTATGAATGCATTTGATAGAGCTATGAATTCGCTCGATGAAAAGT  
1861 TCTCATTCCTCGCATCAGGAAAACAGATAGTAAAGCAGCATGGATGATGATAATAAGGTTG  
1921 TTGTGTTTGAACGTGGTGAACCTGGTATTTGTATTCAACTTCCACCCAAATAACACATACG  
1981 AAAGGTATAAAAGTTGGATGTGACTTGCCAGGGAAATACAGAGTTGCACTGGACAGTGTG  
2041 CTTGGGAATTTGGTGGCCATGGAAGAGCTGGTCATGATGTTGACCATTTACATCACCAG  
2101 AAAGGAATACCTGGAAGTTCCAGAAAACAAATTTCAATGGTCGTCCAAATTCCTTCAAAGTG  
2161 TGTCTCCTGCGCGAAACATGTGTGGCTTATTACAGAGTTGATGAACGCATGTCATAAACTG  
2221 AAGATTACCAGACAGACATTTGTAGTGAAGCTACTACCAACAGCCAATATCGAGGAAAAGT  
2281 ACGAGAACTTAAAGATTTCATCATCTACAAATATCAGTACATCATCTACAAAAAATGCTT  
2341 ATTACAGAGTTGATGAACGCATGTGAGAAAGCTGAAGATTACCAGACAGACATTTGTAGTG  
2401 AGCTACTACTACCAACAGCCAATATCGAGGAGAGTGACGAGAACTTGATGATTGATTAT  
2461 CTACAAATATCAGTAAACATTGGTCAGACTGTTGTAGTTTCTGTTGAGGAGAGAGACAAAG  
2521 AACTTAAAGATTACCATCTGTAAAGCATCATTAGTGTGCTGTTCCAGCTGAATGGGCTG  
2581 ATTCGGATGCAACGCTCTGGGGTGAAGACTAGTCAAGATGATTGATCGATCCTTCTACGTT  
2641 GGTGATCTCGGTCGTCATGATGTCTTCAGGGTGGTAGCATTGACTGATTGCATCATAG  
2701 TTTTTTTTTTTTTTTTTAAAGTATTTCTCTATGCATATTATTAGCATCCAATAAATTTAC  
2761 TGGTTGTTGTACATAGAAAAAAGTGCATTTGCATGTATGTGTTTCTCTGAAATTTTCCCCA  
2821 GTTTTGGTGTCTTGGCTTTGGAGCCAAAGTCTCTATATGTAATAAGAAAACTAAGAACAAT  
2881 CACATATATAAAATGTTAGTAGATTACCA .

4. A plasmid according to any one of the preceding claims, characterised in that the carbohydrates are mono-, di-, oligo- or polysaccharides.
- 5 5. A plasmid according to Claim 4 characterised in that the polysaccharide is starch.
6. A plasmid according to Claim 3 characterised in that the branching enzyme alters the amylose/amylopectin ratio of the starch in plant cells and in plants.  
10
7. A plasmid according to Claims 2 or 3 characterised in that the DNA sequence of the branching enzyme is fused to the regulatory sequences of other genes that ensures a transcription of the branching enzyme coding DNA sequence.  
15
8. A plasmid according to Claim 7 characterised in that the DNA sequence of the branching enzyme is fused in inverted direction to the regulatory sequence of other genes thereby the 3'-end of the coding sequence is fused to the 3'-end of the promoter and the 5'-end of the coding sequence is fused to the 5'-end of the termination signal that gives an anti-sense RNA in the plant produced by the branching enzyme.  
20  
25
9. A plasmid according to Claims 7 or 8 characterised in that the regulatory sequences are promoters and termination signals of plant or viral genes.  
30
10. A plasmid according to Claim 9 characterised in that the promoter is a promoter of the 35s RNA of the cauliflower mosaic virus and the termination signal is the 3'-end of the octopine-synthase-gene of the T-DNA of the Ti-plasmid pTiACH5.  
35

11. A plasmid according to Claim 9 characterised in that the promoter is a promoter of the class I patatin-gene B33.
- 5 12. Plasmid P35 S-BE (DMS 6143)
13. Plasmid P35 S-anti-BE (DSM 6144)
14. Plasmid P33-Be (DSM 6145)
- 10 15. Plasmid P33-anti-Be (DSM 6146)
16. A plant that contains a sequence of at least one plasmid according to any one of Claims 1 to 15.
- 15 17. A plant according to Claim 16 characterised in that the plants are commercially used plants such as maize, barley, wheat, rice, pea, soya bean, sugar cane, sugar beet, tomato, potato or tobacco.
- 20 18. Use of the plasmids claimed in any one of claims 12 to 15, for the production of transgenic plants in which the amylose/amylopectin ratio of the starch is modified.
- 25 19. Use of the plasmids according to Claim 18 characterised in that the plants are commercially used plants.
- 30 20. Use of the plasmids according to Claim 19 characterised in that the plants are maize, barley, wheat, rice, pea, soya bean, sugar cane, sugar beet, tomato, potato and tobacco.

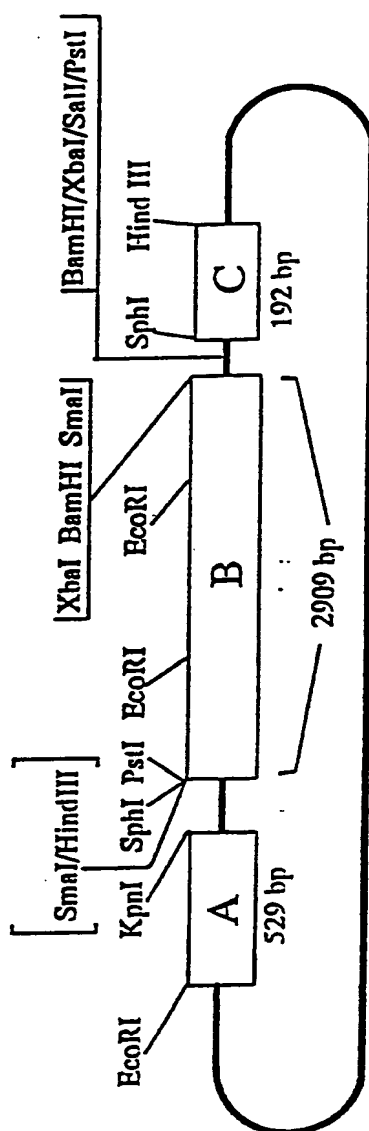
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Plasmid p35 S-BE 13,6 kb

Fig. 1

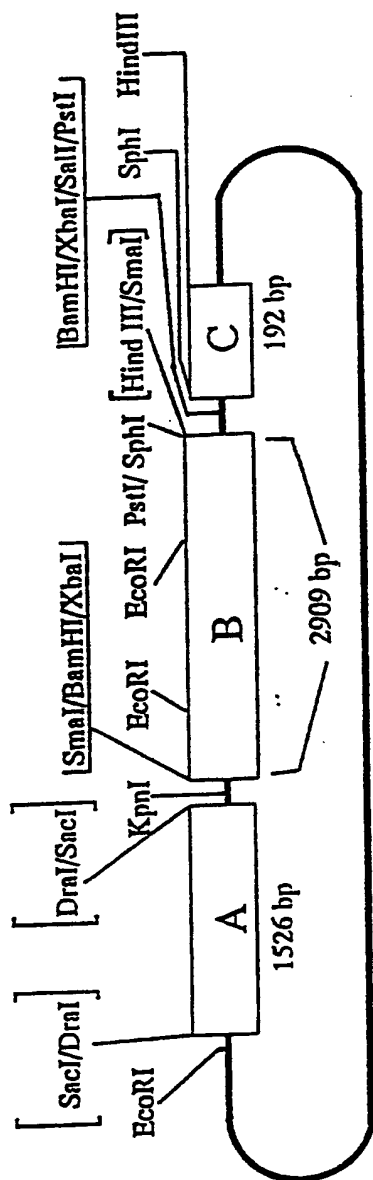
2/4



Plasmid p35 S-anti-BE 13,6 kb

Fig. 2

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Plasmid p33 - BE 14,6 kb

Fig. 3



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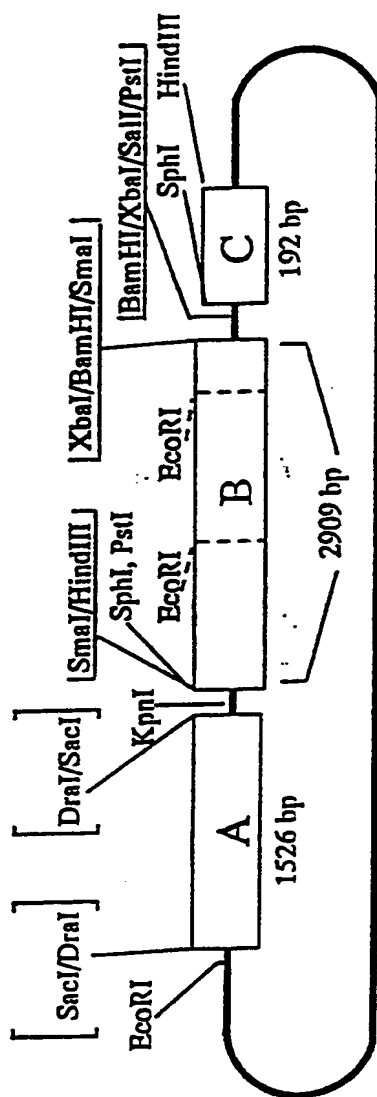


Fig. 4

## INTERNATIONAL SEARCH REPORT

International Application No.

PCT/EP 92/00302

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| <b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                       |                                     |
| According to International Patent Classification (IPC) or to both National Classification and IPC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                       |                                     |
| Int.Cl. 5 C12N15/82;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | C12N15/54;                                                                                                                                                                                                                                            | C12N9/10; A01H5/00                  |
| <b>II. FIELDS SEARCHED</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                       |                                     |
| Minimum Documentation Searched <sup>7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                       |                                     |
| Classification System                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Classification Symbols                                                                                                                                                                                                                                |                                     |
| Int.Cl. 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | C12N ; A01H                                                                                                                                                                                                                                           |                                     |
| Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                       |                                     |
| <b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                       |                                     |
| Category <sup>10</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>                                                                                                                                        | Relevant to Claim No. <sup>13</sup> |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | CELL.<br>vol. 60, 12 January 1990, CAMBRIDGE, NA US<br>pages 115 - 122;<br>BHATTACHARYYA, M. K., ET AL.: 'The wrinkled-seed character of pea described by Mendel is caused by a transposon-like insertion in a gene encoding starch-branching enzyme' | 1,2,4-6                             |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | see the whole document                                                                                                                                                                                                                                | 3,7,9,<br>16,17                     |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | WO,A,9 012 084 (DNA PLANT TECHNOLOGY) 18 October 1990<br>see page 9, line 17                                                                                                                                                                          | 9,16,17                             |
| <p><sup>9</sup> Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"Z" document member of the same patent family</p> |                                                                                                                                                                                                                                                       |                                     |
| <b>IV. CERTIFICATION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                       |                                     |
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| International Searching Authority                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Signature of Authorized Officer                                                                                                                                                                                                                       |                                     |
| EUROPEAN PATENT OFFICE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | MADDOX A. D.                                                                                                                                                                                                                                          |                                     |

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